

# Appendix A

# **Technology Transfer Accomplishments for 1999-2000**

## **Soil & Water Chemistry Research**

### **“Salt Sniffer”**

We have developed a new commercial grade mobilized salinity assessment unit, designated the “Salt Sniffer.” The Unit provides for remote sensing of salinity, with depth profiling information, using two EM-38 units, recently modified by Geonics™ (dual-dipole synchronized electromagnetic inductance meter, EM-38DD). As the unit is driven across a field, continuous electrical conductivity data is collected. This conductivity survey data is then instantly merged with spatial location information from a Trimble Pro-XRS real-time GPS receiver, and then stored into the GPS data logger (which can then be conveniently downloaded at the end of the survey process). The assessment platform can also carry a front mounted soil sampling rig (hydraulic push-probe coring equipment). This allows the platform to be used for both signal data acquisition and site-specific soil sampling operations, increasing its versatility and cost-effectiveness. Six additional units are now operational and used by the Bureau of Reclamation for large scale salinity assessment studies in the Lower Colorado Region.

### **ESAP-95**

The ESAP-95 Software package was developed and released for use with the new mobile salinity assessment equipment. The ESAP-95 software package facilitates the effective use and interpretation of survey conductivity information acquired by nearly all types of mobilized conductivity assessment platforms. (ESAP-95 is an acronym for [E]Ce (salinity) [S]ampling [A]ssessment and [P]rediction software, for Windows 95/98/NT.) This software package was specifically designed to (1) analyze, process, and display automated conductivity survey information, (2) generate optimal soil sampling plans based on the acquired conductivity survey data, (3) convert the survey data into spatial soil salinity information using the soil sample information, and (4) generate field scale salinity inventory statistics, crop yield loss predictions, and spatial salinity maps. The software package employs an easy-to-use, Windows based graphical user interface, and incorporates all of the applied and theoretically based assessment prediction models developed at the Salinity Laboratory since 1989. The software can also be effectively used for multiple types of precision farming sampling applications, in addition to soil salinity inventory and assessment modeling.

### **Lower Colorado Region Salinity Assessment Network**

A cooperative project has been initiated by the George E Brown Jr. Salinity Laboratory and the US Bureau of Reclamation to develop and deploy a salinity assessment network throughout the USBR Lower Colorado Region. This project is being jointly sponsored by the Laboratory's Soil Chemistry and Assessment Research program and the USBR-LCR Water Conservation Field Service program, and coordinated by Chemistry/Assessment personnel. The goal of this project is to foster the growth and development of locally managed salinity assessment programs which can in turn aid

the farmers and growers in each of their service areas. Once deployed, each program will offer rapid soil salinity inventorying and monitoring services, as well as advice on related issues such as soil leaching and reclamation, water conservation, and optimal water management under saline conditions. The five combined programs are expected to eventually serve more than one million acres of irrigated agriculture throughout the Lower Colorado Region.

This is a three year-applied project with a heavy emphasis on the transfer of currently developed Laboratory assessment technology. The immediate project objectives are (1) to develop and establish five salinity assessment programs throughout the Lower Colorado Region, (2) to assist in the transfer of Laboratory developed hardware and salinity software assessment technology to each assessment team, and (3) to train and instruct the assessment teams at each location in the proper use and implementation of this technology. The five locations selected by the USBR for development of assessment programs are as follows: Coachella Valley, Coachella Valley Resource Conservation District, Imperial Valley, Imperial Irrigation District Yuma Agricultural Center, AZ Parker CA, U.S. Bureau of Indian Affairs, Palo Verde Valley.

### **Boron Adsorption/Transport**

We have developed a relationship to predict the B adsorption parameters of a soil for use in the constant capacitance model. The relationship uses readily available soil properties, thus avoiding the need to conduct time-consuming adsorption studies on each soil. The adsorption characteristics are needed for recommendations regarding reclamation of B affected soils and for development of management systems when irrigating with high B waters. Model will also be useful to nonagricultural users including DOE for predicting B transport and evaluating management options for control in discharge water.

### **Modeling Carbon Dioxide Flux**

We have developed the USGF model for prediction of above canopy carbon dioxide flux. The model combines a version of the UNSATCHEM model predicting water flow, water content and carbon dioxide transport and production in the soil, with the GAS-FLUX model for whole canopy photosynthesis. The model was tested against data obtained at the AmeriFlux Wheat Site in Oklahoma. The model, now available, is suitable for prediction of net ecosystem fluxes, and can be used to evaluate the representation of processes in the large carbon exchange and global circulation models.

### **GIS**

The GIS-linked solute transport software and salinity assessment technology for preparing maps of salt-affected soils have been demonstrated to the Broadview Water District. David Cone, manager of the Broadview Water District, has received maps inventorying the salt-affected soils for the district as well as maps showing where the greatest salt-loading is occurring within individually farmed fields. This spatial information provides the district with a useful site-specific tool for modifying irrigation and drainage management to reduce salt loads to drainage water and for advising farmers on future crop and irrigation strategies.

## Plant Science & Food Safety Research

An evaluation of salt and boron tolerance of eucalyptus trees for the University of California/Salinity Drainage Program, Prosser Trust, and California Department of Water Resources was completed. Crop and water use functions were developed for the management of eucalyptus trees grown in agroforestry plantations and irrigated with brackish waters in the San Joaquin Valley (SJV). In response to irrigation with boron-contaminated saline waters, the trees grew poorly, were inefficient water users, and did not meet the requirements necessary for drainage water reuse programs. As a result, research priorities of state and federal agencies have been redirected to alternative cropping and management systems.

A two-year study has been initiated for the University of California/Salinity Drainage Program to identify useful crops for production potential in sequential water reuse systems. High quality forage crops are currently in short supply in the Central Valley. Therefore, forage species, including alfalfa, trefoils, paspalum, alkali sacaton, tall wheatgrass, kikuyu grass, and bermuda, are under evaluation at moderate (15 dS/m) and high (25 dS/m) salinities. The interactive effects of salinity and potentially toxic trace elements (Se and Mo) on forage yield and nutritive quality will be determined. The information developed will benefit growers in the SJV in two ways: by providing management options that will reduce the volumes of saline drainage effluents and at the same time, by offering the opportunity to fill the unmet needs for high quality forages.

A study of host-insect pest interactions is in its third, and final year, for the University of California/Salinity Drainage Program. To date, 62 *Atriplex* accessions have been screened for high salt tolerance and their ability to accumulate Se from saline substrates of different ion composition (e. g. chloride- or sulfate-dominated). The effect of leaf-Se on survival, development, and behavior of the lepidopteran pest, *Spodoptera exigua*, and the insect vector of curly top diseases, *Circulifer tenellus* (beet leafhopper) is under investigation. Information on Se biomagnification e. g. from insect to avians and fish, will be determined.

Lesquerella (*Lesquerella fendleri*) produces a seed oil that has desirable industrial applications. A genotype, WCL-SL1, with improved salt tolerance was developed in cooperation with the ARS-USDA Water Conservation Laboratory, Phoenix, AZ. The new lesquerella selection was registered with the Crop Science Society and seed was deposited in the National Seed Storage Laboratory. Several growers and plant breeders have obtained seed with the intentions of testing the crop at selected sites in Arizona and New Mexico.

Provided advice to numerous national and international students, home owners, growers, consultants, farm advisors, extension specialists, and university scientists on salinity-fertility interactions and many aspects of salt and boron tolerance of various plant species.

# **Soil Physics & Pesticide Research**

## **Pesticide Detoxification**

We have developed a simple, safe and cost-effective method to reclaim activated carbon that has been contaminated with methyl bromide or other similar fumigation gases (e.g. methyl iodide, chloropicrin, 1,3-dichloropropene, propargyl bromide). The process uses activated charcoal that has been wetted with a thiosulfate-containing solution to trap and destroy the fumigation gas. The chemical reaction produces harmless by-products. The method only requires that fumigation gases be pumped through a charcoal bed containing a thiosulfate solution and this could be easily accomplished at the fumigation site. The only disadvantage of this method is that the fumigation gas is not recovered for reuse. However, this is of minor consequence since most fumigation gases are relatively inexpensive. A related patent was developed to quickly and inexpensively destroy certain fumigants used in containment structures, eliminating emissions to the atmosphere.

This research has been further extended by the discovery that thiosulfate salts will also degrade another class of pesticides, the chloroacetamides, which includes alachlor, metalochlor, propachlor and acetochlor. Adding thiosulfate salts to contaminated (i.e., from spillage) or treated soil provides a means for detoxifying pesticide residues in soil.

## **New Method To Determine the Permeability of Agricultural Films**

Plastic tarps are currently used during soil fumigation to control fumigant emissions to the atmosphere. These films have been shown to be permeable to fumigant vapors and result in appreciable losses to the atmosphere. New low-permeability films are being developed to reduce fumigant emissions and increase efficacy. A rapid, reliable and sensitive method has been developed to measure the permeability of agricultural films to fumigant vapors, an integral part of any new management practice. To create a standardized method, the method estimates the mass transfer coefficient of fumigant compounds across agricultural films. The mass transfer coefficient is a measure of the film's resistance to chemical diffusion. The mass transfer coefficient is a fundamental property of the film-chemical combination and independent of the concentration gradient across the film. This method uses static sealed cells; fumigant vapor is spiked to one side of the film and the concentrations on both sides of the film are monitored until equilibrium. A mathematical model is fitted to the data to obtain the mass transfer coefficient. The method will be submitted to ASTM for possible adoption as a standard method.

## **Computer Software**

The Soil Physics group over the years developed a large number of computer models to predict the movement of water and dissolved chemicals (pesticides, fertilizers, salts, toxic trace metals) in soils and groundwater. Since 1990 some 6000 copies have been made available upon request to a variety of users worldwide (universities, soil and groundwater professionals, private consulting firms, extension personnel, and users in such federal agencies such as NRCS, DOE, EPA, NRC, USGS, NASA and NOAA). Additionally, copies are being distributed by EPA, the International Ground

Water Modeling Center (IGWMC) of the Colorado School of Mines (Golden, CO), and several software clearing houses; several codes can be downloaded directly from USSSL's web site ([www.ussl.ars.usda.gov/MODELS/MODELS.HTM](http://www.ussl.ars.usda.gov/MODELS/MODELS.HTM)).

Two of the models (the windows-based HYDRUS-1D and -2D software packages) are being used to predict water, solute and/or heat movement in the unsaturated zone between the soil surface and the groundwater table, including groundwater itself. The models are being distributed through a CRADA between IGWMC and ARS. The software packages are being used not only for typical agricultural applications (such as for irrigation and drainage management, virus and pesticide transport, and soil salinization or reclamation studies), but also many for soil and ground water pollution (and remediation) studies involving non-agricultural chemicals (such as radioactive waste, as well as pollutants being released from industrial and municipal waste disposal sites). The CRADA has been extremely beneficial to both ARS and IGWMC by facilitating a more effective distribution of the software to a variety of users in research and management, reaching users outside of traditional agriculture, providing faster service to customers, providing interaction among users through a web-based electronic user group, and obtaining critical feedback on how to further improve the software.

## **Hydraulic Characterization of the Vadose Zone**

Computer models are now increasingly used in research and management to study or predict water flow and solute transport processes in the unsaturated (vadose) zone between the soil surface and the groundwater table. The unsaturated hydraulic functions are key input data for such models. These functions can be either measured directly at great cost, or estimated more conveniently in an indirect manner from more easily measured data based using pedotransfer functions. During the past year we released a powerful windows-based program (Rosetta, version 1.0) to rapidly estimate the unsaturated hydraulic properties from surrogate soil data such as soil texture and bulk density.

Rosetta uses neural network analysis to estimate the soil water retention and unsaturated hydraulic conductivity functions, and their uncertainty, in a hierarchical manner from limited data (such as soil textural class) to more extensive input data sets (such as sand, silt and clay percentages and the bulk density). This hierarchical approach is of a great practical value because it permits optimal use of available input data. The program is finding widespread application in subsurface flow and transport problems, and in studies of regional and global climate. NASA, DOE, NRCS, USGS and EPA are among its users. Rosetta can be downloaded directly from the USSSL's web site:

[www.ussl.ars.usda.gov/MODELS/rosetta/rosetta.htm](http://www.ussl.ars.usda.gov/MODELS/rosetta/rosetta.htm).